

# TITLE OF THE INVENTION

## CARRYING APPARATUS AND IMAGE FORMING APPARATUS

The present application is a continuation of  
Serial No. 10/406,459, filed April 4, 2003, which is a  
5 continuation of application Serial No. 09/922,704,  
filed August 7, 2001, and the entire contents of each  
such application are incorporated herein by reference.

## BACKGROUND OF THE INVENTION

10 The present invention relates to a carrying  
apparatus for conveying a paper sheet and an image  
forming apparatus which are comprised, for example,  
in an electrophotographic copying machine.

In many electrophotographic copying machines,  
15 images can be formed on both surfaces of a paper sheet.  
To form images on both surfaces in this kind of copying  
machine, a paper sheet is supplied from a paper sheet  
feed cassette to an image forming section through  
a paper sheet carrying route (hereinafter simply  
20 called an ADU), and an image is formed on one surface.  
The paper sheet on which an image has been formed is  
then stacked and contained in an intermediate tray.  
Subsequently, the paper sheet stacked and contained in  
the intermediate tray is fed again to the image forming  
25 section, and an image is then formed on its back  
surface. Thus, images are formed on both surfaces of  
a paper sheet which is then fed out onto a sheet

discharge tray.

Meanwhile, electrostatic charges have been applied to paper sheets stacked on the intermediate tray, for example, through a transfer process at the image forming section. Therefore, paper sheets easily tend to be fed stuck together when they are fed again from the intermediate tray.

In addition, since a paper sheet having a surface on which an image has been formed must once be stacked and contained in the intermediate tray, an image cannot be formed sequentially on its back surface. Time loss is therefore caused so that the image forming efficiency is lowered.

To solve the above-described problems that layered paper sheets are fed and the image forming efficiency is lowered, a development has been made in an electrophotographic copying machine which adopts so-called non-stack ADU.

That is, this kind of electrophotographic copying machine carries out continuous image formation on surfaces of a plurality of sheets, excluding the intermediate tray from the ADU. Then, these paper sheets are directly sent to the image forming section, reversed by reverse carrying means, and an image is formed on the back surface of the paper sheet.

In some cases, the non-stack ADU is used with an accounting device such as a coin controller attached

thereto. If data of total 4 pages are double-side-  
printed on two paper sheets in an electrophotographic  
copying machine attached with the accounting device,  
for example, there may be a case that inserted money  
5 runs short at the time point when printing on pages 1,  
2, and 4 pages.

In this case, the paper sheet on which the third  
page should be printed should be discharged without  
carrying out printing or should be kept in the ADU in  
10 the apparatus.

However, the non-stack ADU includes a curved  
corner part. If a paper sheet is kept at this corner  
part, the paper sheet is curled into the shape of the  
corner part.

15 The appearance of the paper sheet is deteriorated  
and a transfer failure may occur. In addition, paper  
sheets cannot be discharged, with their order arranged  
properly, and there may be a drawback that paper sheets  
jam while conveying them.

#### 20 BRIEF SUMMARY OF THE INVENTION

The present invention has been made in view of the  
actual situation as described above, and has an object  
of providing a carrying apparatus and an image forming  
apparatus which are capable of carrying an object to be  
25 carried (to which an image should be transferred) in  
excellent condition, without curling the object, even  
if the object is temporarily stopped and held.

A carrying apparatus according to the present invention comprises: a carrying device for carrying an object to be carried, along a carrying route having a corner part; a control device for temporarily  
5 stopping and holding the object carried by the carrying device; and a detection device for detecting the object positioned at a corner part of the carrying route, wherein if the detection device detects the object when the control device stops carrying the object,  
10 the control device controls the carrying device such that the carrying device carries the object until the detection device does not detect the object any more and the carrying device then stops carrying the object.

An image forming apparatus according to the  
15 present invention comprises: an image forming device for forming an image on an image carrier; a transfer device for transferring the image formed by the image forming device, to an object to which the image should be transferred; a reverse carrying device for carrying  
20 the object having a surface to which the image has been transferred, along a reverse carrying route having a corner part, thereby to reverse and feed the object again to the transfer device; a control device for temporarily stopping and holding the object carried  
25 by the reverse carrying device, if necessary; and a detection device for detecting the object positioned at the corner part of the reverse carrying route,

wherein if the detection device detects the object when the control device stops carrying the object, the control device controls the carrying device such that the carrying device carries the object until the  
5 detection device does not detect the object any more and the carrying device then stops carrying the object.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may  
10 be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

15 The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the  
20 embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a schematic structural view showing an electrophotographic copying machine according to an embodiment of the present invention;

25 FIG. 2 is a view showing a state in which a paper sheet is being fed to an image transfer section;

FIG. 3 is a view showing a state in which a paper

sheet is being fed out with an image transferred thereto;

FIG. 4 is a view showing a state in which the paper sheet fed out from the image transfer section is being fed in the reverse direction, and a following paper sheet is being fed into the image transfer section;

FIG. 5 is a view showing a state in which the paper sheet fed in the reverse direction is being fed into a reverse carrying route, and a following paper sheet is being fed out with an image transferred thereto;

FIG. 6 is a view showing a state in which the paper sheet fed into the reverse carrying route is being carried, and the following paper sheet is being fed in the reverse direction;

FIG. 7 is a view showing a state in which an image is being transferred to the back surface of the paper sheet fed out from the reverse carrying route, and the following paper sheet is being fed into the reverse carrying route and carried;

FIG. 8 is a view showing a state in which the paper sheet with an image formed on its back surface is being discharged onto a sheet discharge tray, and an image is being transferred to the back surface of the following paper sheet and carried;

FIG. 9 is a view showing a state in which the

following paper sheet with an image formed on its back surface is discharged onto the sheet discharge tray; and

FIG. 10 is a block diagram showing the drive control system for paired carrying rollers on the reverse carrying route.

#### DETAILED DESCRIPTION OF THE INVENTION

In the following, the present invention will be explained with reference to an embodiment shown in the drawings.

FIG. 1 is a structural view showing an electrophotographic machine as an image forming apparatus according to an embodiment of the present invention.

The electrophotographic machine comprises an apparatus body 1. An image forming section 2 for forming an image on a paper sheet as an object to be carried (e.g., a transfer-target material) in an electrostatic photographic method, a sheet feeder 3 for carrying and supplying a paper sheet for the image forming section 2, and a reverse carrying apparatus 4 for reversing the front and back surfaces of the paper sheet and for returning the paper sheet to the sheet feeder 3. Since the reverse carrying apparatus 4 does not comprise an intermediate tray, the apparatus serves as a so-called non-stack ADU.

The image forming section 2 comprises rotatably a photosensitive drum 6 as an image carrier. Provided in

the peripheral part of the photosensitive drum 6 along the rotating direction of the drum are members for executing a so-called electrostatic photographic process by means of a process CPU (not shown).

5           More specifically, the photosensitive drum 6 is constructed by an application type OPC charged in the minus polarity, and this photosensitive drum 6 includes a conductive base member and a photosensitive layer covering the surface of the conductive base member.  
10       The photosensitive layer has a film thickness of 15 to 30  $\mu\text{m}$  and a dielectric constant of 2.0 to 5.0. The conductive base member of the photosensitive drum 6 is grounded.

          Provided in the peripheral part of the photo-  
15       sensitive drum 6 along the rotating direction thereof are a charger 7, an optical scanning system (not shown) for emitting imaging light 8, a developing device 9, a transfer device 10, a separator 11, a cleaning device 12, and a discharger 13.

20       The sheet feeder 3 includes a sheet feed cassette 15 and a carrying route 16 for carrying a paper sheet supplied from the sheet feed cassette 15 to the upside. Paper sheets P are contained in the sheet feed cassette 15, and are fed one after another by rotation of the  
25       sheet feed roller 14.

          The carrying route 16 is provided along the vertical direction. Paired carrying rollers 17, paired



resist rollers 18, an image transfer section 19, paired fixing rollers 20, and paired discharge rollers 21 are provided respectively from the side of the lower part to the side of the upper part on the carrying route 16.

5 A sheet discharge tray 22 is provided in the side of the paired discharge rollers 21 in which paper sheets are discharged.

The reverse carrying device 4 has a reverse carrying route 24 which connects the sheet discharge  
10 side of the paired rollers 20 with the sheet introducing side of the paired resist rollers 18. The reverse carrying route 24 is constructed by a horizontal part 24a, a corner part 24b in the upper side, a vertical part 24c, a corner part 24d in the  
15 lower side, and a substantial horizontal part 24e. The corner part 24b in the upper side, the vertical part 24c, and the corner part 24d in the lower side are respectively provided with pairs of carrying rollers 25a, 25b, and 25c.

20 Meanwhile, upper and lower detection sensors 27a and 27b are provided in the upstream sides of the paired rollers 25a and 25c provided at the upper and lower corner parts 24b and 24d in the sheet carrying direction.

25 FIG. 10 is a block diagram showing the drive control system of the reverse carrying apparatus 4.

The upper and lower detection sensors 27a and 27b

are connected to a control device 30 through a signal circuit, and the control device 30 is connected to a drive motor 31 through a control circuit. The drive motor 31 serves to rotate and drive the pairs of  
5 carrying rollers 25a to 25c.

Also, the control device 30 is connected with a fee counter 39 through a signal circuit. The fee counter 39 is attached to an accounting device such as a coin controller or the like which will be explained  
10 later. The fee counter 39 counts inserted money and calculates the balance remaining.

The control device 30 receives a money insertion signal or a no-balance signal concerning the fee, thereby to control driving of the paired carrying  
15 rollers 25a to 25c on the reverse carry route 24.

Next, explanation will be made of a double-sided image forming operation with reference to FIGS. 1 to 9.

When forming images on both sides, the surface of the photosensitive drum 6 is charged by the charger 7  
20 at first, and imaging light 8 is irradiated on the surface of the charged photosensitive drum 6, so that an electrostatic latent image corresponding to an original document image is formed on the surface of the charged photosensitive drum 6. This electrostatic  
25 latent image is sent to the developing device 9 by rotation of the photosensitive drum 6 and is supplied with magnetic toner as a developing agent from the

developing device 9, to form a magnetic toner image.

At this time, a paper sheet P is supplied by rotation of the sheet feed roller 14 and is clamped and carried by the paired carrying rollers 17. This paper  
5 sheet P is aligned by the paired resist rollers 18 and is thereafter supplied to the image transfer section 19 between the photosensitive drum 6 and the transfer device 10. Here, the magnetic toner image on the photosensitive drum 6 is transferred to the paper sheet  
10 P. The paper sheet P on which the magnetic toner image has been transferred is separated from the photosensitive drum 6 and carried by the operation of the separator 11. As shown in FIG. 3, this paper sheet is then supplied to the paired fixing rollers 20 where the  
15 transferred toner image is fixed to the paper sheet P and is fed out toward the discharge tray 22.

After the paper sheet P is fed by a predetermined amount, the paper sheet P is fed in the reverse direction, as shown in FIG. 4, and a following paper  
20 sheet P is carried along the carrying route 16. Subsequently, as shown in FIG. 5, the preceding paper sheet P is carried out along the reverse carrying route 24, and a toner image on the photosensitive drum 6 is transferred to the following paper sheet P which is  
25 then fed out. After the following paper sheet P is fed by a predetermined amount, it is also fed in the reverse direction as shown in FIG. 6 while the

preceding paper sheet P is also carried continuously along the reverse carrying route 24. Thereafter, the preceding paper sheet P is fed into the image transfer section 19, reversed as shown in FIG. 7, and a toner  
5 image is transferred to the back surface thereof. The following paper sheet P is carried along the reverse carrying route 24.

The preceding paper sheet P with a toner image transferred to its back surface is discharged onto the  
10 discharge tray 22, as shown in FIG. 8. At this time, the following paper sheet P reversed is fed to the image transfer section 19, and a toner image is transferred to its back surface. Thereafter, the following paper sheet P is fed as shown in FIG. 9,  
15 and is carried out onto the discharge tray 22.

Meanwhile, there is a case of using the above-described stack-less ADU attached with an accounting device such as a coin controller. For example, if data of four pages should be printed on both surfaces of two  
20 paper sheets by an electrophotographic copying machine, there is a case that money runs short at the time point when printing of the first, second, and fourth pages are finished. In this case, the paper sheets will be directly discharged without printing the third page or  
25 will be kept on the reverse carrying route 24.

However, it would be unkind to the user to discharge the paper sheets P without printing the third

page.

Otherwise, if the paper sheet P is kept on the reverse carrying route 24, the paper sheet P may be positioned at the corner part 24b (or 24d) of the reverse carrying route 24. If a paper sheet P is positioned at the corner part 24b (or 24d), the paper sheet P is curled along the corner part 24b (or 24d).

Hence, in the present invention, if a paper sheet P is positioned at a corner part 24b (or 24d) and detected by a detection sensor 27a (or 27b) when the paper sheet P is kept, a detection signal from the sensor is transmitted to the control device 30. Upon transmission of the detection signal, the control device 30 does not stop but continues rotating the paired carrying rollers 25a, 25b, and 25c by the drive motor 31. As a result, the paper sheet P is fed from the corner part 24b (or 24d). Accordingly, the detection sensor 27a (or 27b) does not detect the paper sheet P any more, and the control device 30 then stops the drive motor 31 to stop rotating the paired carrying rollers 25a, 25b, and 25c.

As described above, in the present invention, if a paper sheet P is positioned at the corner part 24b (or 24d) and detected by the detection sensor 27a (or 27b) when the paper sheet is temporarily kept on the reverse carrying route 24, the paired carrying rollers 25a, 25b, and 25c are kept rotating until the paper

sheet P is fed out from the corner part 24b (or 24d). Therefore, no paper sheet P stays at the corner part 24b (or 24d), so that curling of paper sheets P can be prevented.

5           Accordingly, paper sheets P can be maintained in an excellent condition, and failures in transfer of images can be prevented. In addition, the occurrence of jamming during carrying can be prevented, and paper sheets can be discharged in an orderly fashion.

10           In the above embodiments, the detection sensors 27a and 27b are respectively provided on the upstream sides of the paired carrying rollers 25a and 25c in the sheet carrying direction. The present invention, however, is not limited hitherto. The sensors may  
15           be respectively provided in the downstream sides of the paired carrying rollers 25a and 25c or may be respectively provided in the upstream and downstream sides of the paired carrying rollers 25a and 25c in the sheet carrying direction.

20           Further, one or more detection sensors may be provided between the upper and lower corner parts 24b and 24d on the reverse carrying route 24 so that a paper sheet P can be detected steadily.

          Additional advantages and modifications will  
25           readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments

shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.